

The incidence of pinworm (*Enterobius vermicularis*) in pre-school and school aged children in the Eastern Slovakia

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Summary

Helminth infections caused by *Enterobius vermicularis* have a cosmopolitan character and most often affect the paediatric pre-school and school age population. The presented study was conducted to determine the prevalence of *E. vermicularis* in the analyzed population of children in the Eastern Slovakia. The Graham's scotch tape method was used to investigate the presence of *Enterobius vermicularis* eggs in 390 specimens. The analyzed set consisted of 218 girls and 172 boys, divided by age into three groups – aged from 5 months to 2 years, aged from 3 to 6 years, and aged from 7 to 15 years. Investigation of perianal scotch tapes of children for the presence of *E. vermicularis* eggs revealed the prevalence of *E. vermicularis* was $P = 3.59\%$. Depending on the incidence of *E. vermicularis* infection, we detected no statistically significant difference ($p > 0.05$). The prevalence of *E. vermicularis* in boys was $P = 4.07\%$, and in girls $P = 3.21\%$. The highest prevalence of *E. vermicularis* was recorded in the group of children aged from 3 to 6 years ($P = 5.03\%$). Most of the samples were positive at age 4 and 5. The lowest prevalence was in the group of children aged from 5 months to 2 years ($P = 0.97\%$), and the prevalence of *E. vermicularis* in the group of children aged from 7 to 15 was $P = 3.91\%$. The difference in the incidence of *E. vermicularis* infection among different age groups of children was not statistically significant ($p > 0.05$).

Enterobius vermicularis nematode infection and enterobiasis currently represents a major public health problem in Slovakia. At the present its occurrence is the most frequent in the paediatric population. Therefore it is important to introduce a targeted hygienic-epidemiological measure in children's collectives, what also should include proper and effective diagnostics and frequent recurrent therapy.

Keywords: *Enterobius vermicularis*; helminthiases; enterobiasis; children population; prevalence

Introduction

Infections with *Enterobius vermicularis* nematodes occur in the human population worldwide, although *E. vermicularis* infection and enterobiasis are more common in the temperate zone than in the tropic one. The species of *Enterobius gregorii* was recorded in Europe, Africa, and Asia, but it is probably not a different species (Nakano *et al.*, 2006). Enterobiasis is one of the most frequent

infections and affects nearly 1 billion people across all socio-economic classes (Lohiya *et al.*, 2000). The most commonly infected population is the infant population, and the individuals living in collectives. The prevalence decreases with the growing age of children and by gradual acquisition of hygienic habits. Infection transmission is carried out by the faecally-oral route of transmission by consuming of *E. vermicularis* infectious eggs. After ingestion of the infectious eggs, larvae are released in the small intestine

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and the adult individuals settle in the colon. Its common occurrence is in the caecum and terminal ileum of the small intestine. Transmission of infection can also occur after handling clothing or bed linen, contacting surfaces and objects in the environment that are contaminated with eggs. A small number of eggs can be transported by air, by inhalation and subsequent swallowing of infectious eggs. Their further development is the same as for ingested eggs. Coupling between adult individuals takes place in the colon. Pregnant females migrate to the perianal area, especially during the sleep of the host where they lay eggs. Each female produces approximately 10,000 eggs. Female migration causes marked itching (pruritus). Autoinfection is often and occurs by transferring the infectious egg by hand into the mouth from the site of intense itching. The time interval from the infected eggs consumption to laying the eggs by adult females in the perianal area is approximately one month. The adult lifespan is about two months long. The larvae in eggs develop and the eggs become infectious within 4 to 6 hours under optimal conditions. Re-infection or migration of newly hatched larvae from anal skin back into the rectum may occur, but the frequency of occurrence is unknown. The resistance of eggs in the environment is relatively high. They can survive for 2 – 3 weeks on clothing, bed linen, or other objects (Burkhart & Burkhart, 2005).

Diagnosis of enterobiasis is performed by applying a transparent adhesive tape in the perianal area immediately after waking up followed by subsequent microscopic diagnosis (Garcia, 2007).

The classic signs of the disease are perianal and vaginal pruritus caused by female migration and egg sticking. Most infections are asymptomatic. Cases of heavy nematode infestation cause insomnia, weight loss, hyperactivity, teeth grinding, abdominal pain, and vomiting. *E. vermicularis* are not vectors of any known pathogens. In children, especially in a case of heavy nematode load, the neurological symptoms such as nervousness, restlessness, irritability, and distraction that may affect the growth of children may occur (Burkhart & Burkhart, 2005; Smolyakov *et al.*, 2003), emotional instability and enuresis (Brooker & Bundy, 2009). In addition to pronounced pruritus in the area of the rectum and the perineal region occur mainly at night, which is associated with continuous scratching of the area around the rectum that leads to small wounds what is associated with development of secondary bacterial infections including bacterial dermatitis and folliculitis (Gutiérrez, 2000). Occasionally, after laying the egg, the parasite in the skin in the perianal area can migrate into the vagina instead of back into the rectum. This causes vulvovaginitis. In severely infected women and girls, migration into the vagina may cause a mucosal vaginal discharge. Uterine infection caused by *E. vermicularis* can cause vaginal bleeding (Al-Rufaie *et al.*, 1998; Burkhart & Burkhart, 2005; Smolyakov *et al.*, 2003).

Hong *et al.* (2002) described the case of ovarian enterobiasis where the presence of a degenerate adult *E. vermicularis* with a number of viable eggs was detected in the parenchymal ovary.

A lot of studies indicate a possible association between *E. vermicu-*

aris infection and the appendicitis (Mansouri, 2017; Aydin, 2007; Da Silva *et al.*, 2007; Ramezani & Dehghani, 2007). Parasitic infections of the appendix are rarely the cause of acute appendicitis. Massive *E. vermicularis* infection can imitate the symptoms of acute appendicitis (Dunphy *et al.*, 2017), without any histological evidence of acute inflammation (Risio *et al.*, 2016). It should be considered in the children with abdominal pain whether this is a case of acute appendicitis and thus avoid unnecessary surgical removal of the appendix (Dunphy *et al.*, 2017).

In addition to the occurrence in female genital organs, the other extraintestinal localizations were found. Such as kidney (Cateau *et al.*, 2010), pelvis as a pelvic abscess caused by *E. vermicularis*, what causes peritonitis in the peritoneal cavity (Das *et al.*, 2001), as well as in the genito-urinary tract of a man with the nematode found in the prostate and eggs in the prostate secretion (Zahariou *et al.*, 2007).

Material and Methods

In this study, 390 samples of perianal scotch tapes were examined for the presence of *E. vermicularis* eggs in the examined children population originating in various regions of the Eastern Slovakia. The analyzed set consisted of 218 girls and 172 boys. By age, the file was divided into three age groups. The first group consisted of children aged between 5 months and 2 years, the second group of children aged 3 to 6 (pre-school age children), and the third group of children aged 7 to 15 years (school age children). To examine the presence of *Enterobius vermicularis* eggs, Graham's perianal scotch tapes method was used to observe the preparation microscopically for the presence of *E. vermicularis* eggs after pressing the transparent adhesive tape to the anal plicae (without washing the anal region for 1 – 2 days) and sticking the tape to the slide (Graham, 1941; Garcia, 2007). For the statistical evaluation of the results, a chi square test (χ^2) was used using SPSS. Statistical significance was confirmed when the p-value was less than 0.05.

Ethical Approval and/or Informed Consent

All procedures performed in studies involving human participants were in accordance with ethical standards of the institutional ethical committee and with the 1964 Helsinki declaration and its later amendments.

Results

As determined by the ovoscopic examination of 390 samples of perianal scotch tapes in the studied children population, the prevalence of *E. vermicularis* was P = 3.59 % (Table 1).

Depending on the incidence of *E. vermicularis* infection, we detected no statistically significant difference ($p > 0.05$). The number of positive samples was the same in both sexes ($n = 7$). The prevalence of *E. vermicularis* in boys was P = 4.07 % and in girls

Table 1. Prevalence (P) of *Enterobius vermicularis* in the monitored children population.

<i>Enterobius vermicularis</i>	
Number of examined samples	N = 390
Number of positive samples	n = 14
P (%)	3.59 %

P = 3.21 %. The highest prevalence of *E. vermicularis* was recorded in the group of children aged from 3 to 6 years (P = 5.03 %). The most positive samples were in group of 4 and 5 years old kids. The lowest prevalence was in the group of children aged from 5 months to 2 years (P = 0.97 %) and the prevalence of *E. vermicularis* in the group of children aged from 7 to 15 was P = 3.91 %. The difference in the incidence of *E. vermicularis* infection among the different age groups of children was not statistically significant ($p > 0.05$). The results of the examinations are summarized in Table 2 and Fig. 1.

In 8 samples of perianal scotch tapes, the presence of *Ascaris lumbricoides*, and in 2 samples of *Trichuris* spp was detected. Positive samples came from the children aged 2, 3, and 6 years old.

Discussion

Enterobiasis is not considered to be a serious disease, but the morbidity level in the world is significant, especially in children. Eosinophilic enterocolitis, appendicitis and inflammatory bowel disease have been reported as a consequence of enterobiasis (Sah *et al.*, 2006).

The prevalence of *E. vermicularis* P = 3.59 % was found in the investigated children population from the Eastern Slovakia. Similar results from an epidemiological study on the occurrence of enterobiasis in children and adolescents from the north-eastern region of Poland conducted in 2008 – 2009 showed 3 % prevalence (Zukiewicz *et al.*, 2011), however, in 2013 – 2015 the overall prevalence in Poland was 10.1% (Kubiak *et al.*, 2017). Crotti and D'Annibale (2006), in a 2002 – 2003 study conducted in Italy, found the presence of *E. vermicularis* eggs in 13.4 % children. In the western Europe, the prevalence of *E. vermicularis* may be 30 – 50 % (Scully, 2011; Burkhart & Burkhart, 2005). The prevalence

among children in some communities is up to 61 % in India, 50 % in England, 39 % in Thailand, 37 % in Sweden, and 29 % in Denmark (Burkhart & Burkhart, 2005). The prevalence of enterobiasis in Turkey in children attending elementary schools varies between 5.4–67 % (Çeliksöz *et al.*, 2005), and 42.6 % in children in Russia (Chernyshenko *et al.*, 2003). Also in Tyrol, it has been shown to be the most frequently occurring intestinal helminthiasis, and representing about a half (49.7 %) of diagnosed cases (Tomaso *et al.*, 2001). In the United States, 40 million infected people with the highest prevalence in children, individuals in close contact, in collectives, in families (Lohiya *et al.*, 2000) are to be estimated. Thumb sucking (Burkhart & Burkhart, 2005) and fingernail biting (Cook, 1994), has been shown to increase the incidence and rate of recurrence.

Depending on the incidence of *E. vermicularis* infection, there was no statistically significant difference ($p > 0.05$), what was consistent with the results of various other studies (Li *et al.*, 2015; Wang *et al.*, 2016).

Enterobiasis occurs predominantly in children at age 5 – 14 (Cook, 1994). The highest prevalence of *E. vermicularis* was recorded in the group of children aged from 3 to 6 years (P = 5.03 %). The most positive samples were in 4 and 5 years olds who are pre-school children. The sensitivity of the infant population to the prevalence of helminthic infections is declining. This change in the susceptibility may be partly due to a change in children's behaviour or activities. Five to six-year-olds are more frequently in contact in kindergartens than children at the age of one and two years (Sang *et al.*, 2011). Our results also confirmed the lowest prevalence in the group from 5 months to 2 years (P = 0.97 %). The prevalence of *E. vermicularis* in the group of monitored children aged 7 – 15 years was P = 3.91 %. The difference in the incidence of *E. vermicularis* infection among different age groups

Table 2. The prevalence of *Enterobius vermicularis* (P) v in the monitored children population in dependence on sex and age.

Sex	n	P (%)	X ²
Boy N= 172	7	4.07	
Girl N= 218	7	3.21	0.649076
Age			
5 m – 2 years N= 103	1	0.97	
3 – 6 years N= 159	8	5.03	0.220356
7 – 15 years N=128	5	3.91	

N – number of examined samples, n – number of positive samples, P – prevalence, X² – chí square test, p – value of p significance level ($\alpha=0.05$)

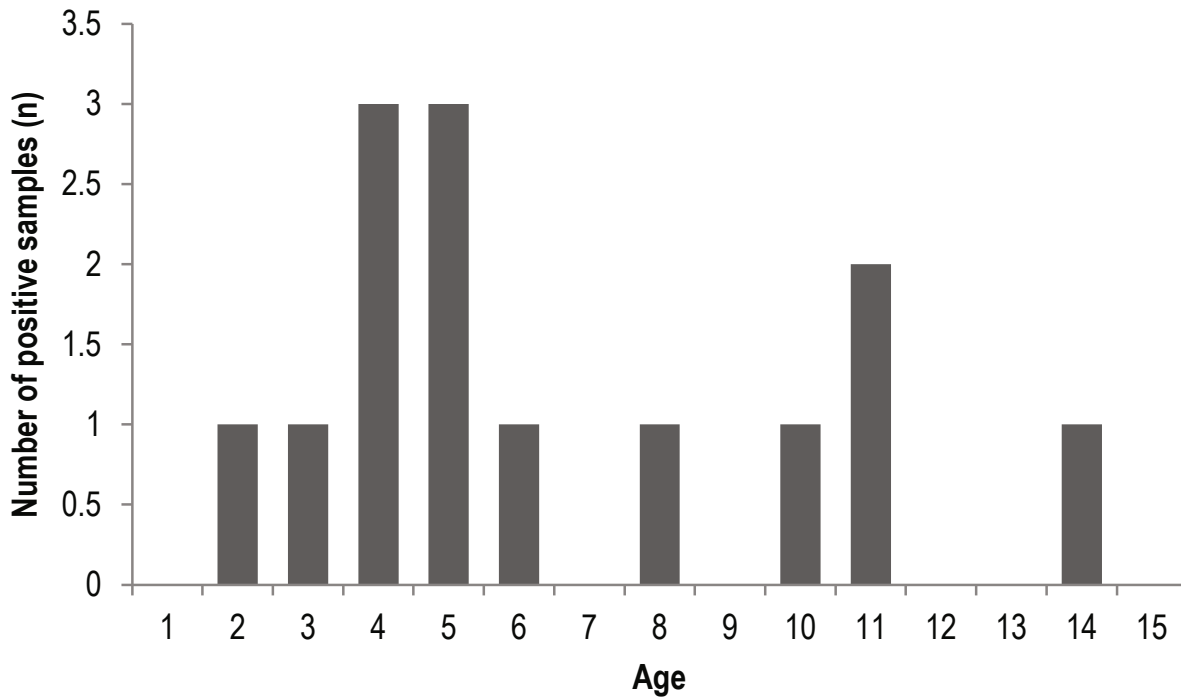


Fig. 1. Positive samples to *Enterobius vermicularis* in dependence on age.

of children was not statistically significant ($p > 0.05$). Older children are less likely to play on the floor, in clay, sand, put their fingers in their mouths, and wash their hands before the food and after toilet, what it is in not a typical case in younger children (Suraweer *et al.*, 2015). Higher immune responses in older children as well as conscious hygienic habits, including personal hygiene, reduce the susceptibility to endoparasitic infection (Juriš *et al.*, 2014).

Likewise, Hong-Mei *et al.* (2015) reported that younger children (aged two to six years) were more likely to have infections than older children (Hong-Mei *et al.*, 2015). Anuar *et al.* (2016) found the prevalence of enterobiasis in children aged from 1 to 6 years. From their results, the overall rate of children's positivity for the presence of *E. vermicularis* eggs was 12.5%. The infection prevalence is age dependent. A higher rate of infection was observed in children aged from 5 to 6 years. Significant risk factors influencing the transmission of infection were thumb sucking and a large family of positive children. The authors report that the cause could be inadequate personal hygiene of children and playing with toys contaminated by *Enterobius* eggs.

According to Juriš *et al.* (2014), in children patients with pulmonary diseases of infectious and non-infectious etiology, in whom endoparasitic infections were diagnosed, the increased levels of IgE (in 40% of positive patients), elevated Eo levels (in 45% positive patients), elevated Lym (in 40% of positive patients) were statistically significantly higher in the patients positive to helminthiasis. In 8 specimens of perianal scotch tape preparations, we detected the presence of *Ascaris lumbricoides*, and in 2 samples also

Trichuris spp. eggs. Although the method of perianal scotch tape preparations is not a standard method for the diagnosis of geohelminths *A. lumbricoides* and *Trichuris* spp. that use flotation methods, it can indirectly point to the presence of a massive infection by these helminthiasis and running ovulation of female *A. lumbricoides* when the eggs are secreted by the stool. *E. vermicularis*, unlike geohelminths, can be reproduced in humans without passing through the developmental cycle phase in the external environment in the soil. Therefore, interhuman transmission is easy (Lohiya *et al.*, 2000).

E. vermicularis infection therapy should be biphasic with a single repetition after 2 weeks. Benzimidazole preparations of mebendazole (2×100 mg for 3 days), or albendazole (400 mg once) are used. Even here the dose was repeated after 3 weeks. Albendazole is not recommended in children under two years of age. However, the therapy itself for cure is not sufficient. Adequate personal hygiene, hygiene of the environment, thorough washing and ironing of underwear and bed linen are required. In case of positive control examination, it is necessary to repeat the therapy for the whole family. The time period for developing *E. vermicularis* eggs to adult stage is 14 days. To prevent autoinfection, it is necessary to administer two antihelminth doses (the second after 14 days). Mebendazole causes death only of adult helminth individuals, and not eggs or larvae. Surviving eggs and larvae in the host's gut can mature into new adults within 14 days. The second dose, which is 14 days after the first administration of the antihelminth, is crucial to the destruction of these new adults. The second dose given be-

fore 14 days would be ineffective for later mature adults and after 14 days female eggs would be produced (Russell, 1991; Kastner *et al.*, 1992).

It is also important to treat contacts that may be infected but are undetectable, negative for the presence of oocytes in perianal scotch tape preparations (during the out-of-ovulation period of female helminths), because reinfection of the recently treated individuals may occur. For effective management of enterobiasis therapy, all contacts in the household should be treated with two-phase doses of anthelmintics, with repetition after 14 days (Lohiya *et al.*, 2000).

Conclusion

Infection with *Enterobius vermicularis* and enterobiasis is currently a serious worldwide public health problem with the most common occurrence in the paediatric population. It is therefore important to introduce targeted intervention. The measures to prevent the spread of enterobiasis require two-phase therapy for the sick (with repetition after 14 days of the first dose of anthelmintics), therapy of infected individuals who are undetectable (negative for the presence of oocytes in perianal scotch tape preparations, including all-contact therapy. Health education should be done with a focus on the children population as the most risky group, parents, guardians, and teachers. Hygiene measures to prevent infection should be targeted at specific age groups of children, taking into account the highest rate of infection in pre-school children. Particular emphasis should be placed on keeping the personal hygiene, and environmental hygiene.

Because of the high rate of *E. vermicularis* recurrence in a collective environment such as nursery schools and primary schools, it is important to wash the hands with soap and warm water, disinfect hands after using the toilet, before eating and change diapers in the smallest children.

Conflict of Interest

The authors declare that they have no conflict of interest.

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